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Results of Inspection/Maintenance Catalyst Tests on a 1975 Dodge Dart

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by

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16. ABSTRACT

The purpose of the test program was to determine whether or not a car with an inactive catalyst could be made to pass I/M short tests through maladjustment of the engine idle mixture, idle speed, and initial timing. Exhaust emissions and temperatures were both measured for each maladjustment. The Federal Three Mode and Two Speed Idle Test were run for each vehicle test condition. In addition, the potential of catalyst diagnostic tests was investigated. For these tests the effect of disconnecting the air pump or a spark plug on exhaust emissions and temperatures was determined. These tests were performed in conjunction with the above emission and temperature mapping. This report presents the measured data of a short program designed to determine the ability of existing I/M scenarios to detect an inactive catalyst.

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Abstract

The purpose of the test program was to determine whether or not a car with an inactive catalyst could be made to pass I/M short tests through maladjustment of the engine idle mixture, idle speed, and initial timing. Exhaust emissions and temperatures were both measured for each maladjustment. The Federal Three Mode and Two Speed Idle Test were run for each vehicle test condition.

In addition, the potential of catalyst diagnostic tests was investigated. For these tests the effect of disconnecting the air pump or a spark plug on exhaust emissions and temperatures was determined. These tests were performed in conjunction with the above emission and temperature mapping.

This report presents the measured data of a short program designed to determine the ability of existing I/M scenarios to detect an inactive catalyst.

Background

As the Inspection/Maintenance effort is expanded, it becomes more important that the test procedures be able to reliably and quickly detect failed vehicle catalysts.

Because of the relatively high cost of replacing a catalyst, there is the possibility that, rather than replacing the catalyst, attempts will be made to fool the I/M short tests through judicious maladjustments of the engine. Idle mixture, idle speed, and initial timing changes can easily be made on many vehicles. Adjusting these engine parameters could potentially allow a failed vehicle to pass I/M short tests even though the vehicle's actual emissions would cause it to fail the Federal Test Procedure.

In order to gain some experience with these problems prior to undertaking any larger efforts, this small test program was undertaken. This report presents the data on one vehicle.

Test Vehicle Description

A 1975 Dodge Dart, with a California emissions control system, was adjusted to manufacturer's specifications. This vehicle is an inline 6 cylinder with air pump, catalyst, and EGR for emission control. A more complete description of the vehicle is given in the test vehicle description in the Appendix.

Thermocouples were installed before and after the catalyst to measure exhaust pipe skin temperature. Several thermocouples were installed. The data presented here are for the thermocouples installed 1 1/2 inches from the junction of the catalyst cone with the exhaust pipe.

Raw exhaust taps were also installed immediately before and after the catalyst.

Test Procedures

The vehicle was tested using the Federal Three Mode (F3M) and Two Speed idle test procedures. Also, there was one hot LA-4 to evaluate the overall emission control of the baseline vehicle. Except for the LA-4, all tests were raw vehicle exhaust samples. The F3M consisted of high speed (52 mph, at 16.0 actual horsepower), low speed (25 mph at 7.5 actual horsepower), idle drive, and idle neutral test. The vehicle hood was open and the auxiliary fan was on for these tests.

The Two Speed idle consisted of a 2500 rpm neutral and an idle neutral test. The vehicle hood was closed and the auxiliary fan was off for these tests.

The vehicle was tested in stock configuration, with one sparkplug disconnected, with the air pump disconnected, and with a combination of these. The complete test sequence matrix was:

Vehicle Configuration

	Stock	1 Plug Disconnected	Air Pump Disconnected	1 Plug and Air Pump Disconnected
F3M	X		X	
2 Speed	X	X	X	X

(A sample test data sheet is contained in the Appendix).

The vehicle was initially tested with the idle mixture, idle speed, and timing set to the manufacturers specifications. The engine CO was also measured by taking CO values before the catalyst with the air pump disconnected while the engine idled.

To avoid confusion with the other CO measurements, the before the catalyst engine CO measurements taken with the air pump disconnected and the engine at idle, will be called "reference CO" values.

While maintaining idle speed, the mixture screw was leaned out until engine misfire occurred. (Misfire was defined as the point at which a rapid increase in HC emissions occurred with little increase in CO emissions). The engine was then adjusted rich until misfire just ceased. This was the lean reference CO setting.

Tests were then run at two intermediate reference CO values between the stock reference CO and lean reference CO values. The vehicle was also tested at the lean reference CO setting.

Idle rpm Changes

The preceding mixture procedure was repeated with the idle rpm set to stock idle rpm +100 rpm and then stock idle rpm +200 rpm.

Timing Changes

The preceding mixture procedure was repeated with the timing retarded both 5° and 10° from stock.

For all before and after catalyst measurements, the HC and CO concentrations were measured with a Sun Analyzer Model EPA-75.

Test Results

The test results are tabulated in the six tables following. The data is presented with no attempts made to analyze the data. A few test observations are noted below:

The before and after catalyst skin temperatures were very sensitive to thermocouple location. Skin temperatures typically increased 6-8° per inch for each inch upstream of the catalyst. Similarily, skin temperatures typically decreased 6-8° per inch for each inch downstream of the catalyst. Also, upstream and downstream temperatures were nearly identical under most test conditions.

The vehicle was equipped with a ported spark advance. Therefore, the 100 and 200 rpm idle speed changes would cause changes in idle timing for some conditions as the throttle plate was opened for higher idle speeds.

The Federal Three Mode idle in neutral test many times gave different emission values than the Two Speed idle in neutral test. This difference is attributable to the hood being open, fan on, for the Federal Three Mode and the hood being closed, fan off, for the Two Speed Idle Tests

The Federal Three Mode idle neutral test with the air pump disconnected should have given results identical to the reference CO value for the given test. Often this did not happen and is attributable to the vehicle engine compartment temperature increasing throughout a given test sequence.

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 Dodge Dart
Emission control system - Air Pump, Catalyst EGR

Engine

type	Inline 6, 4 cycle
bore x stroke	3.40 X 4.125 in.
displacement	225 CID/3687 cc
compression ratio	8.4:1
fuel metering	1 Venturi, carburetor
fuel requirement	unleaded, tested with Indolene HO unleaded

Drive Train

transmission type	3 speed automatic

Chassis

type	4 door sedan
tire size	D78 X 14
inertia weight	3500 lbs.
passenger capacity	6

Emission Control System

basic type	air pump catalyst EGR calibrated to 1975 California standards

I/M CATALYST TESTING: RAW EXHAUST HC, CO, TEMPERATURE DATA SHEET

Technicians: _____ Test No._____

Dyno 004 Baseline _____ Other _____ Date _____

Timing _____ Idle Mixture _____ Idle RPM _____

Set 1750 lbs. IW

FEDERAL THREE MODE	Before Catalyst			After Catalyst		
	HC	CO	Temp	HC	CO	Temp
hood OPEN fan ON,						
set ___ IHP @ 52 mph						
52 mph - max. 3 min.	_____	_____	_____	_____	_____	_____
set ___ IHP@ 25 mph						
25 mph - max. 3 min.	_____	_____	_____	_____	_____	_____
Idle (drive)	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
TWO SPEED IDLE:						
hood CLOSED, fan OFF						
2500 ± 100 rpm	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
Disconnect plus wire _____						
TWO SPEED IDLE						
2500 ± 100 rpm	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
Disconnect air pump and plug supply line _____						
TWO SPEED IDLE						
2500 ± 100 rpm	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
Connect plug wire ____						
FEDERAL THREE MODE						
hood OPEN, fan ON						
set ___ IHP @ 52 mph						
52 mph - max. 3 min.	_____	_____	_____	_____	_____	_____
set ___ IHP @ 25 mph						
25 mph - max. 3 min.	_____	_____	_____	_____	_____	_____
Idle (drive)	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
TWO SPEED						
hood CLOSED, fan OFF						
2500 ± 100 rpm (N)	_____	_____	_____	_____	_____	_____
Idle (N)	_____	_____	_____	_____	_____	_____
unplug supply line and connect air pump _____						

Table I

I/M Catalyst Testing

HC Before Catalyst ppm

Test Number	Test Configuration			Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
		Percent CO	RPM	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	55	60	52	28	60	33	1360	1580
4	+Lean Intermediate	1.3%	750(N)	50	50	35	20	80	20	1340	1580
3	+Lean Intermediate	.75%	750(N)	50	60	40	25	80	30	1380	1530
2	+Lean Limit	.01%	750(N)	42	50	30	20-80	60-90	25	1360	1460
5	Stock + 100 RPM	1.0%	850(N)	50	50	38	30	80	35	1380	1490
8	+Lean Intermediate	.75%	850(N)	50	50	40	60	70	80	1380	1510
7	+Lean Intermediate	.55%	850(N)	50	50	40	120	75	60	1380	1440
6	+Lean Limit	.35%	850(N)	60	55	60	175	70	120	1350	1430
9	Stock +200 RPM	1.0%	950(N)	50	50	40	20	70	20	1370	1400
12	+Lean Intermediate	.75%	950(N)	50	55	45	30	70	25	1390	1440
11	+Lean Intermediate	.60%	950(N)	52	60	49	30	75	30	1360	1420
10	+Lean Limit	.48%	950(N)	45	50	40	30	55	40	1330	1400
12.5	Stock	1.9%	750(N)	60	65	58	30	80	35	1420	1730
13	5° Retard	1.10%	750(N)	42	50	25	20	50	20	1390	1630
14	+Lean Intermediate	.4%	640(N)	40	55	30	50	60	30	1400	1630
15	10° Retard	.25%	750(N)	30	50	35	125	75	90	1480	1680
16	+Lean Intermediate	.35%	590(N)	40	40	20	35	60	15	1440	1650
13A	5° Retard (1)	1.10%	750(N)	40	48	30	30	60	25	1380	1540
14A	5° Retard (2)	.25%	750(N)	50	65	55	150	70	120	1430	1410
15A	10° Retard (3)	1.15%	750(N)	18	60	35	75	100	40	1440	1650

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno HP set 2 hp high.

Table I (cont)

I/M Catalyst Testing

HC Before Catalyst ppm

Test Number	Test Configuration			Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
		Percent CO	RPM	Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	1800	2000	100	90	145	120	140	125
4	+Lean Intermediate	1.3%	750(N)	1970	2000	90	80	100	75	140	85
3	+Lean Intermediate	.75%	750(N)	1900	2000	100	88	110	80	75	90
2	+Lean Limit	.01%	750(N)	1940	2000	85	85	68	60	130	50
5	Stock + 100 RPM	1.0%	850(N)	2000	2000	100	90	88	180	120	110
8	+Lean Intermediate	.75%	850(N)	1950	2000	115	90	85	175	120	80
7	+Lean Intermediate	.55%	850(N)	2000	2000	115	90	100	130	130	140
6	+Lean Intermediate	.35%	850(N)	2000	2000	90	80	75	250	140	210
9	Stock + 200 RPM	1.0%	950(N)	1970	2000	85	75	100	80	90	75/70
12	+Lean Intermediate	.75%	950(N)	1910	2000	90	85	95	100	100	120
11	+Lean Intermediate	.60%	950(N)	1940	2000	82	72	100	70	100	75
10	+Lean Limit	.48%	950(N)	1900	2000	85	80	100	225	110	175
12.5	Stock	1.9%	750(N)	2000	2000	125	90	140	110	150	115
13	5° Retard	1.1%	750(N)	2000	2000	90	75	85	125	100	100
14	+Lean Intermediate	.4%	640(N)	2000	2000	80	70	70	80	110	150
15	10° Retard	.25%	750(N)	2000	2000	100	75	100	150	100	70
16	+Lean Intermediate	.35	590(N)	2000	2000	70	70	65	150	100	120
13A	5° Retard (1)	1.1%	750(N)	2000	2000	80	75	90	90	100	80
14A	5° Retard (2)	.25%	750(N)	2000	2000	95	82	--	--	100	150
15A	10° Retard (3)	1.15%	750(N)	2000	2000	85	80	90	150	120	120

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table II

I/M Catalyst Testing

CO Before Catalyst in %

Test Number	Test Configuration	Percent CO	RPM	Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
				52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	.1	.08	.87	.48	.12	.61	.12	.47
4	+Lean Intermediate	1.3%	750(N)	.1	.09	.30	.20	.13	.27	.10	.22
3	+Lean Intermediate	.75%	750(N)	.09	.08	.22	.17	.12	.24	.10	.21
2	+Lean Limit	.01%	750(N)	.09	.09	.10	.12	.13	.12	.11	.10
5	Stock + 100 RPM	1.0%	850(N)	.09	.08	.28	.19	.13	.27	.10	.21
8	+Lean Intermediate	.75%	850(N)	.09	.08	.20	.17	.12	.20	.10	.19
7	+Lean Intermediate	.55%	850(N)	.09	.08	.12	.14	.12	.18	.11	.17
6	+Lean Intermediate	.35%	850(N)	.08	.08	.10	.15	.13	.16	.11	.11
9	Stock + 200 RPM	1.0%	950(N)	.07	.07	.29	.18	.12	.20	.10	.20
12	+Lean Intermediate	.75%	950(N)	.08	.07	.21	.16	.11	.17	.09	.15
11	+Lean Intermediate	.60%	950(N)	.09	.08	.20	.17	.13	.20	.11	.18
10	+Lean Limit	.48%	950(N)	.08	.08	.13	.13	.11	.14	.10	.15
12.5	Stock	1.9%	750(N)	.09	.09	.62	.36	.13	.42	.11	.39
13	5° Retard	1.1%	750(N)	.1	.09	.45	.30	.12	.38	.11	.22
14	+Lean Intermediate	.4%	640(N)	.1	.09	.16	.13	.13	.15	.10	.13
15	10° Retard	.25%	750(N)	.13	.12	.38	.30	.17	.25	.14	.25
16	+Lean Intermediate	.35	590(N)	.10	.10	.15	.12	.13	.18	.12	.15
13A	5° Retard (1)	1.1%	750(N)	.11	.09	.37	.23	.13	.28	.13	.25
14A	5° Retard (2)	.25%	750(N)	.10	.10	.11	.13	.15	.15	.12	.12
15A	10° Retard (3)	1.15%	750(N)	.12	.10	.43	.32	.16	.40	.13	.30

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table II (cont.)

I/M Catalyst Testing

CO Before Catalyst in %

Test Number	Test Configuration	Percent CO	RPM	Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
				Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	.20	2.1	.14	2.1	2.1	2.0	.24	2.6
4	+Lean Intermediate	1.3%	750(N)	.20	.69	.12	.12	1.0	.93	.24	1.4
3	+Lean Intermediate	.75%	750(N)	.20	1.0	.15	.12	.85	.92	.25	1.3
2	+Lean Limit	.01%	750(N)	.19	.25	.12	.12	.16	.23	.25	.38
5	Stock + 100 RPM	1.0%	850(N)	.20	.55	.13	.13	.50	.70	.22	.80
8	+Lean Intermediate	.75%	850(N)	.18	.65	.12	.11	.30	.45	.23	.60
7	+Lean Intermediate	.55%	850(N)	.21	.35	.12	.12	.40	.50	.22	.75
6	+Lean Intermediate	.35%	850(N)	.20	.31	.12	.12	.14	.20	.22	.40
9	Stock +200 RPM	1.0%	950(N)	.17	.90	.11	.11	.80	.90	.22	1.25/.70
12	+Lean Intermediate	.75%	950(N)	.17	.55	.11	.11	.50	.60	.20	.80
11	+Lean Intermediate	.60%	950(N)	.19	.90	.13	.12	.80	.90	.20	1.25
10	+Lean Limit	.48%	950(N)	.18	.55	.12	.12	.28	.38	.21	.50
12.5	Stock	1.9%	750(N)	.20	1.55	.12	.12	2.00	1.90	.23	2.30
13	5° Retard	1.1%	750(N)	.23	1.06	.14	.14	.95	.95	.22	1.25
14	+Lean Intermediate	.4%	640(N)	.23	.31	.13	.15	.21	.25	.22	.30
15	10° Retard	.25%	750(N)	.25	.80	.20	.17	1.18	.80	.28	1.05
16	+Lean Intermediate	.35	590(N)	.20	.33	.16	.17	.31	.35	.25	.48
13A	5° Retard (1)	1.1%	750(N)	.21	.70	.15	.15	.70	.75	.25	1.0
14A	5° Retard (2)	.25%	750(N)	.21	.23	.16	.14	---	---	.25	.45
15A	10° Retard (3)	1.15%	750(N)	.22	1.10	.18	.16	1.00	1.05	.26	1.10

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table III

I/M Catalyst Testing

Temperature Before Catalyst in °F

Test Number	Test Configuration	Percent CO	RPM	Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
				52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	610	640	580	512	580	570	540	515
4	+Lean Intermediate	1.3%	750(N)	600	630	590	500	550	550	550	520
3	+Lean Intermediate	.75%	750(N)	650	625	565	510	540	555	555	525
2	+Lean Limit	.01%	750(N)	685	640	585	510	570	550	560	520
5	Stock +100 rpm	1.0%	850(N)	630	640	570	500	590	550	565	505
8	+Lean Intermediate	.75%	850(N)	660	650	565	505	570	535	560	500
7	+Lean Intermediate	.55%	850(N)	635	640	575	500	560	535	565	545
6	+Lean Limit	.35%	850(N)	640	625	570	500	580	535	560	515
9	Stock +200 rpm	1.0%	950(N)	625	610	560	500	600	570	565	500
12	+Lean Intermediate	.75%	950(N)	643	620	570	520	580	560	555	520
11	+Lean Intermediate	.60	950(N)	658	600	540	490	560	520	530	472
10	+Lean Limit	.48%	950(N)	740	660	560	478	560	525	550	500
12.5	Stock	1.9%	750(N)	630	615	557	485	565	510	515	479
13	5° Retard	1.10%	750(N)	675	650	568	510	571	550	555	491
14	+Lean Intermediate	.4%	640(N)	748	649	569	487	575	540	568	530
15	10° Retard	.25%	750(N)	815	820	740	576	620	550	580	502
16	+Lean Intermediate	.35%	590(N)	805	735	627	545	656	617	632	552
13A	5° Retard (1)	1.10	750(N)	695	640	550	500	588	561	579	525
14A	5° Retard (2)	.25%	750(N)	635	612	553	496	515	528	536	485
15A	10° Retard (3)	1.15%	750(N)	791	650	609	530	612	578	589	528

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table III (cont.)

I/M Catalyst Testing

Temperature Before Catalyst in °F

Test Number	Test Configuration			Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
		Percent CO	RPM	Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	520	505	620	640	580	495	545	540
4	+Lean Intermediate	1.3%	750(N)	520	510	620	650	600	480	570	540
3	+Lean Intermediate	.75%	750(N)	515	520	600	630	550	480	550	540
2	+Lean Limit	.01%	750(N)	550	510	660	630	580	500	540	540
5	Stock +100 rpm	1.0%	850(N)	550	540	670	650	560	490	575	530
8	+Lean Intermediate	.75%	850(N)	520	---	---	---	---	510	---	---
7	+Lean Intermediate	.55%	850(N)	530	535	630	650	550	500	560	530
6	+Lean Limit	.35%	850(N)	520	525	630	640	590	515	580	530
9	Stock +200 rpm	1.0%	950(N)	530	500	630	625	540	480	590	525/480
12	+Lean Intermediate	.75%	950(N)	530	500	630	650	540	500	628	530
11	+Lean Intermediate	.60	950(N)	500	490	655	620	532	482	562	527
10	+Lean Limit	.48%	950(N)	510	500	645	615	530	465	540	500
12.5	Stock	1.9%	750(N)	507	499	605	642	499	435	566	522
13	5° Retard	1.10%	750(N)	520	511	640	647	515	455	558	507
14	+Lean Intermediate	.4%	640(N)	535	489	719	671	602	482	590	509
15	10° Retard	.25%	750(N)	550	515	730	749	620	512	610	575
16	+Lean Intermediate	.35%	590(N)	590	540	740	755	637	542	595	570
13A	5° Retard (1)	1.10	750(N)	535	525	633	669	610	510	550	549
14A	5° Retard (2)	.25%	750(N)	505	470	450	420	---	---	588	537
15A	10° Retard (3)	1.15%	750(N)	560	510	757	700	582	500	600	520

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table IV

I/M Catalyst

HC After Catalyst ppm

Test Number	Test Configuration	Percent CO	RPM	Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
				52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	25	28	22	20	28	20	190	100
4	+Lean Intermediate	1.3%	750(N)	20	15	10	10	20	10	190	70
3	+Lean Intermediate	.75%	750(N)	20	20	15	10	20	15	200	100
2	+Lean Limit	.01%	750(N)	12	12	10	10	18	10	90	70
5	Stock +100rpm	1.0%	850(N)	20	15	10	10	12	10	180	100
8	+Lean Intermediate	.75%	850(N)	15	12	10	10	20	10	190	100
7	+Lean Intermediate	.55%	850(N)	15	12	10	10	15	10	180	80
6	+Lean Limit	.35%	850(N)	30	15	20	20	20	20	170	120
9	Stock +200 rpm	1.0%	950(N)	12	15	10	9	15	8	180	100
12	+Lean Intermediate	.75%	950(N)	22	20	20	15	22	10	180	120
11	+Lean Intermediate	.60	950(N)	25	25	20	15	25	20	190	100
10	+Lean Limit	.48%	950(N)	19	15	12	9	10	9	180	80
12.5	Stock	1.9%	750(N)	30	30	25	18	32	20	200	100
13	5° Retard	1.10%	750(N)	20	10	10	15	10	10	200	150
14	+Lean Intermediate	.4%	640(N)	18	20	15	5	10	12	200	120
15	10° Retard	.25%	750(N)	20	20	22	25	30	15	220	150
16	+Lean Intermediate	.35%	590(N)	5	20	15	15	10	10	200	120
13A	5° Retard (1)	1.10%	750(N)	15	12	10	12	15	12	180	90
14A	5° Retard (2)	.25%	750(N)	15	20	20	30	20	25	180	100
15A	10° Retard (3)	1.15%	750(N)	8	20	18	20	25	20	220	140

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table IV (cont.)

I/M Catalyst

HC After Catalyst ppm

Test Number	Test Configuration			Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
		Percent CO	RPM	Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	210	1090	50	40	148	120	35	130
4	+Lean Intermediate	1.3%	750(N)	220	170	35	30	85	68	30	80
3	+Lean Intermediate	.75%	750(N)	200	500	42	40	95	75	30	88
2	+Lean Limit	.01%	750(N)	210	170	35	30	20	20	28	20
5	Stock +100 rpm	1.0%	850(N)	240	120	42	30	30	30	30	25
8	+Lean Intermediate	.75%	850(N)	240	200	50	35	30	30	30	25
7	+Lean Intermediate	.55%	850(N)	220	160	45	30	25	25	25	20
6	+Lean Limit	.35%	850(N)	220	100	30	25	20	25	25	20
9	Stock +200 rpm	1.0%	950(N)	230	300	30	28	70	60	25	80/20
12	+Lean Intermediate	.75%	950(N)	200	140	40	35	30	30	30	25
11	+Lean Intermediate	.60	950(N)	220	300	35	30	55	50	25	65
10	+Lean Limit	.48%	950(N)	200	140	40	30	25	30	25	25
12.5	Stock	1.9%	750(N)	360	760	40	35	140	120	40	120
13	5° Retard	1.10%	750(N)	270	380	48	32	65	50	30	60
14	+Lean Intermediate	.4%	640(N)	260	140	35	30	30	30	22	28
15	10° Retard	.25%	750(N)	310	220	55	40	85	45	35	40
16	+Lean Intermediate	.35%	590(N)	240	140	30	25	15	20	20	10
13A	5° Retard (1)	1.10%	750(N)	260	200	35	30	35	30	30	40
14A	5° Retard (2)	.25%	750(N)	280	160	45	35	--	--	30	30
15A	10° Retard (3)	1.15%	750(N)	300	220	30	40	80	70	35	55

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table V

I/M Catalyst Testing

CO After Catalyst in %

Test Number	Test Configuration			Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
		Percent CO	RPM	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	.02	.01	.02	.02	.01	.02	.02	.01
4	+Lean Intermediate	1.3%	750(N)	.01	.01	.01	.01	.01	.01	.01	.01
3	+Lean Intermediate	.75%	750(N)	.01	.01	.01	.005	.005	.005	.01	.01
2	+Lean Limit	.01%	750(N)	.01	.005	.005	.005	.005	.005	.02	.01
5	Stock +100 rpm	1.0%	850(N)	.01	.005	.01	.005	.005	.005	.01	.005
8	+Lean Intermediate	.75%	850(N)	.01	.01	.01	.01	.01	.01	.01	.01
7	+Lean Intermediate	.55%	850(N)	.01	.01	.01	.01	.01	.01	.01	.01
6	+Lean Limit	.35%	850(N)	.01	.005	.005	.005	.005	.005	.01	.005
9	Stock +200 rpm	1.0%	950(N)	.01	.005	.01	.01	.01	.005	.01	.01
12	+Lean Intermediate	.75%	950(N)	.01	.005	.005	.005	.005	.005	.005	.005
11	+Lean Intermediate	.60%	950(N)	.02	.02	.02	.02	.02	.02	.02	.02
10	+Lean Limit	.48%	950(N)	.005	.005	.005	.005	.005	.005	.01	.01
12.5	Stock	1.9%	750(N)	.01	.01	.01	.01	.01	.01	.01	.01
13	5° Retard	1.10%	750(N)	.01	.01	.01	.005	.005	.005	.01	.01
14	+Lean Intermediate	.40%	640(N)	.01	.01	.01	.01	.01	.01	.02	.01
15	10° Retard	.25%	750(N)	.02	.02	.02	.02	.02	.02	.02	.02
16	+Lean Intermediate	.35%	590(N)	.005	.005	.005	.005	.005	.005	.01	.005
13A	5° Retard (1)	1.10%	750(N)	.01	.01	.01	.01	.01	.01	.02	.01
14A	5° Retard (2)	.25%	750(N)	.01	.01	.01	.01	.01	.01	.02	.02
15A	10° Retard (3)	1.15%	750(N)	.02	.01	.01	.01	.01	.01	.02	.02

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table V (cont.)

I/M Catalyst Testing

CO After Catalyst in %

Test Number	Test Configuration			Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
		Percent CO	RPM	Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	.02	.37	.02	.02	1.8	1.6	.02	1.8
4	+Lean Intermediate	1.3%	750(N)	.02	.02	.02	.02	.40	.30	.02	.80
3	+Lean Intermediate	.75%	750(N)	.01	.10	.01	.01	.25	.38	.01	.71
2	+Lean Limit	.01%	750(N)	.02	.01	.01	.01	.01	.01	.01	.01
5	Stock +100 rpm	1.0%	850(N)	.02	.01	.01	.01	.01	.01	.01	.01
8	+Lean Intermediate	.75%	850(N)	.02	.01	.01	.01	.01	.01	.01	.01
7	+Lean Intermediate	.55%	850(N)	.02	.01	.01	.01	.01	.01	.01	.01
6	+Lean Limit	.35%	850(N)	.02	.01	.01	.01	.01	.01	.01	.01
9	Stock +200 rpm	1.0%	950(N)	.02	.18	.01	.01	.27	.50	.01	.60/.01
12	+Lean Intermediate	.75%	950(N)	.02	.01	.005	.005	.01	.01	.005	.01
11	+Lean Intermediate	.60%	950(N)	.03	.12	.02	.02	.22	.32	.02	.72
10	+Lean Limit	.48%	950(N)	.02	.02	.01	.01	.01	.01	.01	.01
12.5	Stock	1.9%	750(N)	.02	.23	.01	.01	1.65	1.60	.01	1.90
13	5° Retard	1.10%	750(N)	.01	.09	.01	.01	.31	.30	.01	.50
14	+Lean Intermediate	.40%	640(N)	.02	.02	.02	.02	.02	.02	.02	.0
15	10° Retard	.25%	750(N)	.02	.02	.02	.02	.61	.02	.02	.19
16	+Lean Intermediate	.35%	590(N)	.01	.01	.01	.005	.01	.005	.01	.005
13A	5° Retard (1)	1.10%	750(N)	.02	.02	.02	.02	.03	.02	.02	.10
14A	5° Retard (2)	.25%	750(N)	.02	.02	.02	.02	---	---	.02	.02
15A	10° Retard (3)	1.15%	750(N)	.02	.02	.02	.02	.55	.45	.02	.22

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table VI

I/M Catalyst Test

Temperature After Catalyst in °F

Test Number	Test Configuration			Federal Three Mode				Two Speed Idle		Two Speed Idle Plug Disconnected	
		Percent CO	RPM	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	590	620	545	538	612	552	786	735
4	+Lean Intermediate	1.3%	750(N)	620	630	540	590	600	555	790	700
3	+Lean Intermediate	.75%	750(N)	630	590	530	495	570	550	750	690
2	+Lean Limit	.01%	750(N)	670	630	560	490	600	540	800	480
5	Stock +100 rpm	1.0%	850(N)	665	630	530	475	610	540	780	710
8	+Lean Intermediate	.75%	850(N)	660	630	535	590	590	525	790	700
7	+Lean Intermediate	.55%	850(N)	650	620	550	480	600	520	800	725
6	+Lean Limit	.35%	850(N)	660	610	530	485	590	540	800	690
9	Stock +200 rpm	1.0%	950(N)	640	600	535	485	600	540	745	685
12	+Lean Intermediate	.75%	950(N)	652	618	545	515	606	530	780	705
11	+Lean Intermediate	.60%	950(N)	648	595	520	480	542	500	730	652
10	+Lean Limit	.48%	950(N)	712	628	520	467	550	500	760	670
12.5	Stock	1.9%	750(N)	652	610	538	502	579	532	760	692
13	5° Retard	1.10%	750(N)	657	630	550	510	605	555	782	700
14	+Lean Intermediate	.4%	640(N)	720	634	538	479	595	549	763	702
15	10° Retard	.25%	750(N)	732	800	675	572	620	550	816	709
16	+Lean Intermediate	.35%	590(N)	762	699	600	530	651	585	812	739
13A	5° Retard (1)	1.10%	750(N)	660	632	545	509	592	568	789	720
14A	5° Retard (2)	.25%	750(N)	630	602	543	492	570	508	771	670
15A	10° Retard (3)	1.15%	750(N)	810	699	591	518	621	568	793	729

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

Table VI (cont.)

I/M Catalyst Testing

Temperature After Catalyst in °F

Test Number	Test Configuration	Percent CO	RPM	Two Speed Idle Plug & Air Pump Disconnected		Federal Three Mode Air Pump Disconnected				Two Speed Idle Air Pump Disconnected	
				Idle Drive	Idle Neutral	52 mph	25 mph	Idle Drive	Idle Neutral	Idle Drive	Idle Neutral
1	Stock	1.8%	750(N)	845	750	600	610	575	510	570	565
4	+Lean Intermediate	1.3%	750(N)	845	770	700	650	570	500	580	570
3	+Lean Intermediate	.75%	750(N)	825	760	670	630	550	510	540	560
2	+Lean Limit	.01%	750(N)	800	760	685	630	560	500	550	575
5	Stock +100 rpm	1.0%	850(N)	860	795	700	650	560	525	595	580
8	+Lean Intermediate	.75%	850(N)	630	—	—	—	—	540	—	—
7	+Lean Intermediate	.55%	850(N)	860	780	700	640	560	520	580	570
6	+Lean Limit	.35%	850(N)	840	775	680	645	580	510	590	565
9	Stock +200 rpm	1.0%	950(N)	835	755	660	620	565	540	580	525/540
12	+Lean Intermediate	.75%	950(N)	838	780	692	645	580	530	600	575
11	+Lean Intermediate	.60%	950(N)	815	750	660	620	550	510	580	520
10	+Lean Limit	.48%	950(N)	820	760	668	618	550	510	530	543
12.5	Stock	1.9%	750(N)	825	735	678	629	523	470	570	559
13	5° Retard	1.10%	750(N)	820	752	700	646	542	499	562	568
14	+Lean Intermediate	.4%	640(N)	837	775	715	660	580	497	570	532
15	10° Retard	.25%	750(N)	861	770	740	718	609	540	605	585
16	+Lean Intermediate	.35%	590(N)	865	758	748	733	630	552	650	595
13A	5° Retard (1)	1.10%	750(N)	837	773	690	676	592	555	562	579
14A	5° Retard (2)	.25%	750(N)	798	725	550	415	—	—	587	550
15A	10° Retard (3)	1.15%	750(N)	851	758	749	685	602	520	592	609

(1) Maintaining idle speed caused vacuum spark advance.
(2) Maintaining idle speed caused vacuum spark advance.
(3) Dyno hp set 2 hp high.

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